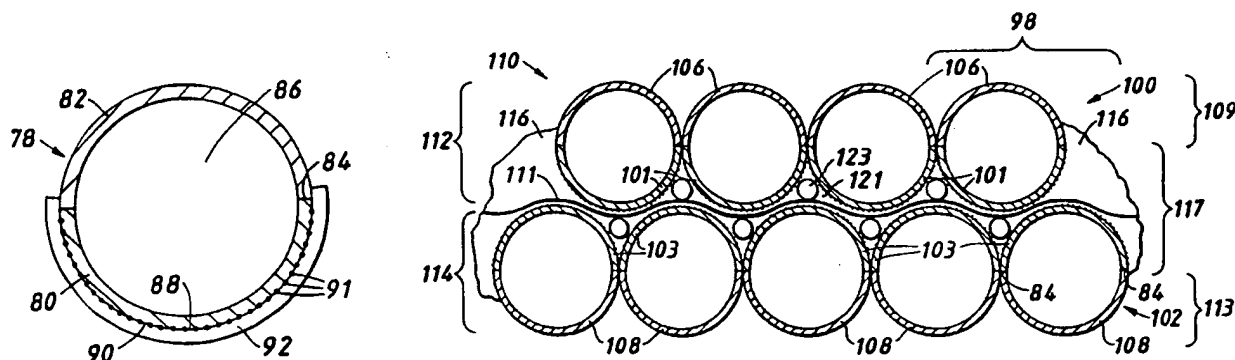




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification 7 : H01M 8/10, 8/24, 8/02, 8/04, 4/86</p>	<p>A3</p>	<p>(11) International Publication Number: WO 00/02274</p> <p>(43) International Publication Date: 13 January 2000 (13.01.00)</p>
<p>(21) International Application Number: PCT/GB99/02131</p> <p>(22) International Filing Date: 1 July 1999 (01.07.99)</p> <p>(30) Priority Data: 9814123.7 1 July 1998 (01.07.98) GB</p> <p>(71) Applicant (for all designated States except US): BG PLC [GB/GB]; 100 Thames Valley Park Drive, Reading, Berkshire RG6 1PT (GB).</p> <p>(72) Inventor; and (75) Inventor/Applicant (for US only): MCLEAN, Gerard, Francis [CA/CA]; 4077 Ebony Terrace, Victoria, British Columbia V8N 3Z2 (CA).</p> <p>(74) Agent: MORGAN, David, J.; BG plc, Intellectual Property Dept., 100 Thames Valley Park Drive, Reading, Berkshire RG6 1PT (GB).</p>		<p>(81) Designated States: AU, CA, CN, IN, JP, KR, SG, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</p> <p>Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p> <p>(88) Date of publication of the international search report: 27 April 2000 (27.04.00)</p>

(54) Title: FUEL CELL STACK MADE OF TUBE CELLS, AND INTERNAL COOLING ARRANGEMENT THEREFOR



(57) Abstract

A PEM-type fuel cell is formed from two transversely arrayed layers (112, 114) of parallel circular cylindrical tubes (78) of equal diameter, between which layers is a layer of membrane material (116). The portions (82) of the tubes that are not to be in electrochemical contact with the membrane are reactant gas-impermeable, and the portions of the tubes that are to be in contact with the membrane are electro-catalyzed. Preferably, the layers of tubes are transversely offset from one other by half the diameter of a tube so as to minimize the thickness of the combined fuel cell in the stack dimension. Adjacent sequential fuel cells in a stack are also preferably transversely offset from each other so as to minimize the total combined thickness of the fuel cells in the stack dimension. Cooling may be provided by conduits running between adjacent tubes in the flow dimension in otherwise unused spaces between the reactant gas-impermeable portions of the tubes of adjacent fuel cells. Porous humidification conduits may also be conveniently provided in similar unused spaces between the tubes.

BEST AVAILABLE COPY

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 99/02131

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H01M8/10 H01M8/24 H01M8/02 H01M8/04 H01M4/86

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 008, no. 209 (E-268), 22 September 1984 (1984-09-22) -& JP 59 096669 A (KOGYO GIJUTSUIN;OTHERS: OJ), 4 June 1984 (1984-06-04) abstract; figures 3,5,7	1,3-5, 13,24, 25,31, 33,34
A	US 3 607 425 A (TITTERINGTON WILLIAM A ET AL) 11 May 1971 (1971-05-11) column 3, line 57 -column 4, line 33; figures 1,3	1,3,4
A	PATENT ABSTRACTS OF JAPAN vol. 1997, no. 10, 31 October 1997 (1997-10-31) -& JP 09 161812 A (KUWABARA AKIRA), 20 June 1997 (1997-06-20) abstract	1
	-/-	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the International filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the International filing date but later than the priority date claimed

- "T" later document published after the International filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the International search

17 February 2000

Date of mailing of the International search report

28/02/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax (+31-70) 340-3016

Authorized officer

D'hondt, J

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 99/02131

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 018, no. 332 (E-1567), 23 June 1994 (1994-06-23) - & JP 06 084532 A (SUMITOMO ELECTRIC IND LTD), 25 March 1994 (1994-03-25) abstract	7
A	PATENT ABSTRACTS OF JAPAN vol. 018, no. 658 (E-1643), 13 December 1994 (1994-12-13) - & JP 06 260190 A (MITSUBISHI HEAVY IND LTD), 16 September 1994 (1994-09-16) abstract	7
A	US 5 252 410 A (WILKINSON DAVID P ET AL) 12 October 1993 (1993-10-12) column 9, line 29 - line 40; figure 3B	1,3,4
A	PATENT ABSTRACTS OF JAPAN vol. 016, no. 095 (E-1175), 9 March 1992 (1992-03-09) - & JP 03 274671 A (MITSUBISHI ELECTRIC CORP), 5 December 1991 (1991-12-05) abstract	
A	US 4 175 165 A (ADLHART OTTO J) 20 November 1979 (1979-11-20)	

BEST AVAILABLE COPY

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 99/02131

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 59096669 A	04-06-1984	JP 1589400 C JP 2018551 B	30-11-1990 25-04-1990
US 3607425 A	11-05-1971	NONE	
JP 09161812 A	20-06-1997	NONE	
JP 06084532 A	25-03-1994	NONE	
JP 06260190 A	16-09-1994	NONE	
US 5252410 A	12-10-1993	WO 9409519 A AU 3054092 A AU 672958 B EP 0664928 A JP 8507402 T	28-04-1994 09-05-1994 24-10-1996 02-08-1995 06-08-1996
JP 03274671 A	05-12-1991	NONE	
US 4175165 A	20-11-1979	AU 522754 B AU 3816678 A CA 1093147 A DE 2831799 A FR 2398392 A GB 1582517 A IT 1105910 B JP 1324477 C JP 54022537 A JP 60047702 B SE 452078 B SE 7807986 A	24-06-1982 24-01-1980 06-01-1981 08-02-1979 16-02-1979 07-01-1981 11-11-1985 27-06-1986 20-02-1979 23-10-1985 09-11-1987 21-01-1979